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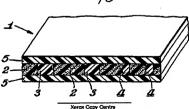
The title of the invention has been amended (Guidelines for Examination in the EPO, A-iii, 7.3).

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Dielectric wavegulde.

A high frequency transmission circuit (1) is provided comprising a continuously porous, planar dielectric sheet (2) having an electromagnetic wave propagating circuit (3,4) therein formed by a dielectric material of a higher permittivity impregnated into portions of the dielectric sheet (2) in the thickness direction thereof. The planar diefectric sheet (2) is expanded of porous tetrafluoroethylene, and the dielectric material used to form the electromagnetic wave propagating circuit be tetrafluoroethylene-hexafluoropropylene copolymer, a tetrafluoroethylene-perfluoroalkylvinyl ether copolymer, a tetrafluoroethylene-ethylene copolymer or a tetrafluoroethylene dispersion.

Fig1.



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HIGH FREQUENCY TRANSMISSION CIRCUIT

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This invention relates to a transmission circuit for the transmission of electromagnetic waves of extremely short wavelength, such as microwaves. millimetre waves and submillimetre waves, and narticularly relates to a planar transmission circuit.

Coaxiel cables, wavequides, microstrip lines, dielectric lines and other such devices are currently used to transmit these types of electromagnetic waves, in all of these devices, a core of round or rectangular cross-section is formed by a dielectric of low dielectric loss and relatively high permittivity for transmitting the travelling wave energy of the electromagnetic wave, and the core is surrounded by a dielectric of lower permittivity. Other forms of high frequency transmission device have not been considered, and there is thus a problem of how to form circuit networks and to increase circuit densitv.

According to the invention, there is provided a high frequency transmission circuit comprising a continuously porous, planar dielectric sheet having a dielectric material of greater permittivity than the dielectric sheet impregnated into portions of said dielectric sheet in the thickness direction thereof to form an electromagnetic wave propagating circuit in said planar dielectric sheet.

In other words, a high frequency transmission circuit is provided comprising a continuously porous, planar dielectric sheet having an electromagnetic wave propagating circuit therein formed by a dielectric material of higher permittivity impregnated into the dielectric sheet in the thickness direction thereof.

The dielectric material forming the electromagnetic wave propagating circuit may be a tetrafluoroethylene-hexafluoropropylene copolymer. tetrafluoroethylene-perfluoroalkylvinyl copolymer. а tetrafluoroethylene-ethylene copolymer or a tetrafluorgethylene dispersion.

The planar dielectric sheet is preferably porous, expanded polytetrafluoroethylene.

It is desirable for the continuous pores of the porous, planar dielectric sheet to be aligned mainly in the thickness direction of the sheet, although even for a planar dielectric sheet whose porosity is unaligned, a similar impregnation result can be accomplished by using a masked impregnation method.

The invention provides a high frequency transmission circuit having good transmission characteristics and capable of being used to expand the circuit in the planar direction. Any desired high frequency circuit can be formed with a thin continuously porous, planar dielectric sheet by lamination or other methods. The creation of high density.

high frequency transmission circuits can also be accomplished.

Preferred embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic cross-sectional, perspective view of one embodiment of a high frequency transmission circuit in accordance with the invention: and

Figure 2 shows a partial sectional view Illustrating one method of making a high frequency transmission circuit in accordance with the inven-

Floure 1 shows a high frequency transmission circuit 1 created by forming electromagnetic wave transmission portions 3 and 4 in portions of a porous, planar dielectric sheet 2, the latter being composed of continuously porous, expanded polytetraffuoroethylene film, and optionally laminating a protective film 5 to the upper and lower surfaces of the sheet 2. The protective films 5 may each be a prepreg sheet of porous, expanded polytetrafluoroethylene.

When expanded polytetrafluoroethylene film of permittivity 1.4 is used as the planar dielectric sheet 2, a powder of tetrafluoroethylene-hexafluoropropylene cocolymer tetrafluoroethylene-perfluoroalkylvinyl copolymer resin, tetrafluoroethylene-ethylene copolymer resin, or the like, with a permittivity of about 2, and a binder, or alternatively, a tetrafluoroethylene resin dispersion and a binder, may be impregnated and fixed in portions of the sheet 2 to form the electromagnetic wave transmission portions 3 and 4. The binder may be a Tefion (R.T.M.) adhesive.

These electromagnetic wave transmission portions 3 and 4 may be formed, for example, as shown in Figure 2, by applying an inverse pattern circuit mask 8 to the planar dielectric sheet 2, then applying the resin powder and binder composition to this circuit pattern portion and allowing natural impregnation to occur due to gravity, or applying a similar mask 6 to the bottom surface of the planar dielectric sheet 2 and facilitating impregnation by means of a vacuum pump 8.

When the composition 7 is dried after being impregnated in this way, electromagnetic wave transmission portions 3 and 4 are formed having a permittivity higher than the planar dielectric sheet

In order to form electromagnetic wave transmission portions 3 and 4 with very sharp boundaries, it is desirable that the continuous porosity of the planar dielectric sheet 2 should be of the smallest scale possible, and that the continuous pores should be aligned as much as possible in the direction of the thickness of planar dielectric sheet 2, i.e. perpendicularly to the plane of the sheet, or that the nomelity should be high in the thickness.

Because the present Invention allows a high frequency transmission circuit to be formed as a thin sheet, and the rectangular shape of the electromagnetic wave transmission portions maintains the plane of polarization, connections can be made without introducing significant error in the direction of the electromatic waves, and multiple layer devices can easily be produced.

Furthermore, because the invention relies upon impregnation into a continuously porous, planar dielectric sheet to form electromagnetic wave transmission circuit portions, thin devices can be produced and very high density transmission circuits can be made. of the preceding claims, having a protective film (5) isminated to at least one face of the planar dielectric sheet (2).

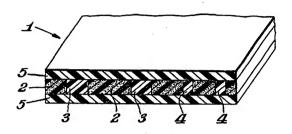
Claima

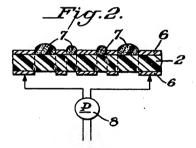
direction.

- 1. A high frequency transmission circuit characterised by a continuously porous, planar dielectric sheet (2) having a dielectric material of greater permittivity than the dielectric sheet in the thickness direction thereof to form an electromagnetic wave propagating circuit (3.4) in said olanar dielectric sheet in
- A transmission circuit according to claim 1, wherein the delectric material of the electromagnetic wave propagating circuit (3,4) is a tetrafluoroethylene-hexafluoropropylene copolymer.
- A transmission circuit according to claim 1, wherein the dielectric material of the electromagnetic wave propagating circuit (3,4) is a tetrafluoroethylene-perfluoroalkylvinyl conolymer.
- 4. A transmission circuit according to claim 1, wherein the delectric material of the electromagnetic wave propagating circuit (3,4) is a tetrafluoroethylene-ethylene copolymer.
- A transmission circuit according to claim 1, wherein the dielectric material of the electromagnetic wave propagating circuit (3,4) is a tetrafluoroethylene dispersion.
- 6. A transmission circuit according to any one of the preceding claims, wherein said planar dielectric sheet (2) is porous, expanded polytetrafluoroethylene.
- 7. A transmission circuit according to any one of the preceding claims, wherein the continuous pores of the planar dielectric sheet (2) are aligned mainly in the thickness direction of the sheet.
 - 8. A transmission circuit according to any one









EUROPEAN SEARCH REPORT

Application Number

FP 89 30 8429

- :	DOCUMENTS CONSI	DERED TO BE RELEVA	INT	
ategory	Citation of document with in of relevant par	dication, where appropriate,	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	ELECTRONICS AND COMMUNICATIONS IN JAPAN, vol. 51-B, no. 3, 1968, pages 50-54; N. KUMAGAI et al.: "Surface waveguide consisting of inhomogeneous dielectric thin film" * Page 52, left-hand column, lines 1-6; pages 52-53, chapter 3; figure 8 *		1	H 01 P 3/16
A	FR-A-1 372 610 (PR * Page 2, left-hand right-hand column,	610 (PRACHE) eft-hand column, line 53 - column, line 9; figure 3 *		,
A	DE-B-1 047 896 (SIEMENS & HALSKE) * Column 1, lines 37-54; column 2, lines 45-50; figure 1 *		1-6,8	
A	5TH EUROPEAN MICROWAVE CONFERENCE - PROCEEDINGS, Hamburg, 1st-4th September 1975, pages 3-12, Microwave Exhibitions and Publishers Ltd, Kent, GB; HG. UNGER: "Optical waveguides" * Page 5, 1ines 6-39; page 6, lines 14-17; figures 8,10 * ELECTRONICS LETIERS, vol. 10, no. 1, 10th January 1974, pages 1-2; P.J.B. CLARRICOATS et al.: "Dielectric waveguides for millimetre-wavelength transmission" * Page 1, left-hand column, lines 1-6; figure 1 * US-A-4 463 329 (SUZUKI) * Whole document *		1	TECHNICAL PIELDS SEARCHED (int. Cl.5)
A			2	G 02 B
A .			1-6,8	
	The present search report has			
Th	Pleas of search HE HAGUE	Date of completion of the sear 09-11-1989		OTTER A.M.
CATEGORY OF CITED DOCUMENTS X: particularly relevant if takes alone Y: particularly relevant if cambade with another document of the same alongory L: decument			wisciple underlying the ent document, but put liling date cited in the applicationed edited for other reasons of the same patent fur.	blished on, or on s

34A/FG4B Veröttentlichte Europäische Patente

H02G 15/117 FR 1994 01 05 00358542 00407468 E-99843 (BE) USB9(D1201 1000 00 00 89402214 ► (73) MILEWSKI, JOHN V. "SANTA FE, NM 87504, P.O. BOX 8029 "US H02G 15/10, 1/14 MILEWSKI, PETER D. "SANTA FE, NM 87504, P.O. BOX 8029 "US ► (73) MORIZOT, JEAN - GUY *F - 75016 PARIS, 65, RUE CHARDON - LAGACHE *FR ► (54) EINKRISTALLWHISKER FÜR ELEKTRISCHEN GLÜHFADEN. ► (54) VERFAHREN ZUM HERSTELLEN EINES DRUCKSTOPFENS UND 1988 03 29 175052 ► (30) US ► (72) MILEWSKI, JOHN V. "SANTA FE, NM 87504 "US VORRICHTUNG ZU DESSEN DURCHFÜHRUNG. MILEWSKI, PETER D. *SANTA FE, NM 87504 *US ► (30) FR 1988 08 05 8810606 ► (72) MORIZOT, JEAN-GUY *F-75016 PARIS *FR HOIM AID? EN E 00000 1004 01 05 00349663 87104027 H02G 15/18 DE 1987 03 19 H01M 4/62, 4/58, 2/14 1000 NE NO 88107034 ► (73) W.R. GRACE & CO.-CONN. *NEW YORK, NEW YORK 10036- 7794, H02G 15/113. 15/013

► (73) SIEMENS AKTIENGESELLSCHAFT *D = 80333 MÜNCHEN.
WITTELSBACHERPLATZ 2 *DE ➤ (54) KATHODISCHE ELEKTRODE ➤ (30) US 1986 03 24 843480 F (54) KABELMUFFE AUS KUNSTSTOFF MIT ELASTISCHEN 842973 DICHTUNGSELEMENTEN IN DEN ABDICHTUNGSBEREICHEN. 110 1086 02 24 1986 03 24 1987 05 05 2714025 1987 08 18 3727557 1986 08 15 DE > (72) ANDERMAN, MENAHEM 'BOYDS MARYLAND 20841 'US (72) PICHLER, KLAUS, ING. (GRAD) *D-8156 OTTERFING *DE JOHNSON, STEVEN LLOYD *CATONSVILLE MARYLAND 21228 *US LUNDQUIST, JOSEPH THEODORE *JESSUP MARYLAND 20794 *US BACHEL, ERNST, ING. (GRAD) *D - 8085 GELTENDORF *DE 00351272 H02K 5/22 FR E - 99845 1994 01 05 00303793 U0184 10294 DE E - 00937 1004 01 05 ► (73) POMPES SALMSON SOCIETE ANONYME A DIRECTOIRE DITE: *F-92504 RUEIL MALMAISON, 3, RUE E. ET A. PEUGEOT B.P. 239 *FR ► (7%) VARTA RATTERIE AKTIENGESELL SCHAFT *D = 30405 HANNOVER WILD WERKE GMBH & CO. PUMPEN - UND APPARATEBAU "D - 44263 DORTMUND, NORTKIRCHENSTRASSE 100 "DE POSTFACH 5 40. AM LEINEUFER 51 *DE (54) GASDICHT VERSCHLOSSENER ALKALISCHER AKKUMULATOR. ► (54) MIT MODULAREM VERBINDUNGSMITTEL AUSGESTATTETER ► (30) DE 1987 08 20 3727766 ► (72) GLASER, HELMUT *SINGAPORE 1015 *SG ELEKTRISCHER MOTOR. > (30) FR 1988 07 13 ► (72) KERNOURS, MICHEL *F = 35370 MONDEVERT *FR CIDON MALIBICE 'E - 53260 ENTRAMMES 'ER HOTE SHE 'EN F = 99838 1004 01 05 00360416 FOURNIER, ALAIN *F-53000 LAVAL *FR 1989 08 18 89308429 ► (73) JUNKOSHA CO. LTD. *SETAGAYA – KU TOKYO 156, 25 – 25. HAHN, MARTIN *D - 4600 DORTMUND 1 *DE HÜRNER JÜRGEN *D - 4600 DORTMUND 41 *DE MIYASAKA 2 - CHOME "JP

MIYASAKA 2 - CHOME "JP

MIYASAKA 2 - CHOME "JP RADZEY, JÜRGEN *D - 5840 SCHWERTE - HOLZEN *DE 1988 08 19 ► (72) HARAYAMA CHIHARU "ATUGI - SHI KANAGAWA "JP EN 1004 01 05 00266501 1989 10 27 ► (73) UNIVERSIDAD NACIONAL DE EDUCACION A DISTANCIA 'ES - 28080 00304066 H01R 4/24 DE F _ 99839 1994 01 05 MADRID, CIUDAD UNIVERSITARIA APARTADO 60149 "ES 88113453 ► (73) SIEMENS AKTIENGESELLSCHAFT *D = 80333 MÜNCHEN. ► (72) LORENTA PARAMO, GABRIEL "ES - 28008 MADRID "ES WITTELSBACHERPLATZ 2 *DE ► (54) ELEKTRISCHE ANSCHLUSSKLEMME. ► (30) DE 1987 08 21 8711376 U 1987 12 15 8716544 U H03G 7/00 EN E-99847 1994 01 05 00206731 DE ► (72) WOHLFART, ARTUR, DIPL. - ING. (FH) "D - 8000 MÜNCHEN 71 "DE BREITSCHAFT, JOSEF, DIPL. - ING. (FH) "D - 8210 PRIEN "DE 1986 06 17 86304654 ► (73) DOLBY, RAY MILTON *SAN FRANCISCO CALIFORNIA 94118, 3340 DE PAUW, JACQUES 'B-8340 DAMME-SIJSELE ' ► (54) SCHALTUNGSANORDNUNG ZUM ABÂNDERN DES DYNAMIKBEREICHES MIT HILFE DES SUBSTITUTIONS- UND 00457675 SUPERPOSITIONSTECHNIK H018 39/64 FR F = 99840 1994 01 05 1991 05 15 91401247 ► (30) US 1985 06 17 744963 H01H 1/08, H01R 13/03, 4/58

770 CFTRA S.A.R.L. "F-91700 STE GENEVIEVE - DES - BOIS, Z.I. LA ► (72) DOLBY, RAY MILTON *SAN FRANCISCO CALIFORNIA 94118 *US CROIX BLANCHE QUEST. 26, RUE DE LA RESISTANCE "FR F (54) ELEKTRISCHER KONTAKT. ► (30) FR 1990 05 17 9006600 ► (72) MARTIN, JEAN - PAUL *F-91280 ST. PIERRE DU PERRAY *FR 00470963 1994 01 05 H031 5/02 DF F - 99848 (86) EP90/00590 90905506 ► (73) DEUTSCHE THOMSON - BRANDT GMBH 'D-78048 VILLINGEN SCHWENNINGEN. HERMANN - SCHWER - STRASSE 3 'DE MOISANT, JEAN - CLAUDE *F - 78390 BOIS D'ARCY *FR ► (54) RUNDFUNKEMPFÄNGER MIT DIGITALER FREQUENZEINGABE. ► (30) DE 1989 04 22 3913278 ► (72) FÜLDNER, FRIEDRICH *D-7730 VILLINGEN *DE E-99841 0042622 1000 10 15 90202730 HO15 3/094 HO4B 10/12 ► (73) PIRELLI CAVI S.P.A. *I-20123 MILANO, PIAZZALE CADORNA, 5 *IT H03K 17/97 E-99849 1994 01 05 ► (54) OPTISCHE VERSTÄRKUNGSEINRICHTUNG MIT NIEDRIGEM 1988 03 24 88104692 RAUSCHEN UND REFLEXION DER PUMPLEISTUNG. 1989 10 30 2219689 HOSK 3/45 HOSM 1/22 ► (30)11 1989 10 30 2219689 ► (72) GRASSO, GIORGIO "I-20052 MONZA (MILANO) "IT RIGHETTI, ALDO "I-20146 MILANO "IT ► (73) ECHLIN INC. *BRANFORD, CT 06405, 100 DOUBLE BEACH ROAD ► (54) IMPULSGENERATOR MIT ABGESCHIRMTEM WIEGANDDRAHT. FONTANA, FLAVIO "1-20032 CORMANO (MILANO) "IT ► (30) US 1987 04 14 1987 07 14 72916 ► (72) OPIE, JOHN E. *STONY CREEK CONNECTICUT 06405 *US H015 3/23 ΕN E-99842 1994 01 05 00242178 1987 04 14 87303260 G03F 7/20, H01J 35/00 ► (73) HAMPSHIRE INSTRUMENTS, INC *ROCHESTER, NY 14610, 10 HO49 775 DE E _ 09850 1994 01 05 00361299 89117386 CARLSON ROAD POST OFFICE BOX 10159 *US ➤ (54) LASERSTRAHLERZEUGER FÜR EINE ► (73) ASCOM ZELCOM AG *CH - 8634 HOMBRECHTIKON, RÖNTGENSTRAHLLITHOGRAPHIE - VORRICHTUNG FIGHTAL STRASSE *CH ► (54) DIGITALES FUNKÜBERTRAGUNGSSYSTEM FÜR EIN AUS ZELLEN 1986 04 15 852108

► (72) ABATE, JOSEPH A. *PITTSFORD, NEW YORK 14534 *US

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1988 09 29

KUNG, ROLAND 'CH-8633 WOLFHAUSEN 'CH GROB, URS *CH - 9403 GOLDACH *CH WELTI, ARNOLD *CH-5200 BRUGG *CH

AUFGEBAUTES NETZ UNTER VERWENDUNG DER BANDSPREIZTECHNIK.

3628/88 F (72) KAUFMANN, HANS "CH - 8625 GOSSAU "CH